**Every Boiler Engineering Code – Intermediate Level Programming**

**Week 2 – Programming Exercises**

1. (15 points) Write a program that creates a dictionary containing the U.S. states as keys, and their capitals as values. (Use the Internet to get a list of the states and their capitals.) The program should then randomly quiz the user by displaying the name of a state and asking the user to enter that state’s capital. The program should keep a count of the number of correct and incorrect responses. (You need import random module in the program.)

**(When you run your program, try 10 states, and take screen shot of the results.)**

1. (15 points) Fundamental theorem of number theory states that every natural number n can be expressed as a product of prime numbers, called its prime factorization. E.g. 15 = 3 x 5, 20 = 2 x 2 x 5.

You are required to write a Python function prime factors(n) which accepts a natural number as the input argument and returns a list of all the prime factors of n in ascending order.

**(Use 20, 666, 4020 to test your program.)**

1. (20 points) Two natural number p,q are called coprime if there are no common prime factors in their prime factorization. E.g. 15 and 20 are not coprime because 5 is a common prime number in their prime factorization, while 20 and 9 are coprime. The Euler’s phi function, φ(n), counts the number of all natural numbers ≤ n which are coprime to n. E.g. φ(9) = 6, as all natural numbers ≤ 9 are 1,2,3,4,5,6,7,8,9. And out of these, the numbers coprime to 9 are 1,2,4,5,7 and 8, a total of 6 natural numbers.

You are required to write a Python function totient(n) that accepts a natural number as input argument and returns the following:

1. a list of all the natural numbers less than or equal to n which are coprime to n; and

2. the result of the Euler’s phi function when run on n.

E.g. totient(9) should return [1,2,4,5,7,8], 6

You can use your function prime factors from Problem 2. to determine if two numbers are coprime or not.

**(Use 44, 100, and 1000 to test your program)**